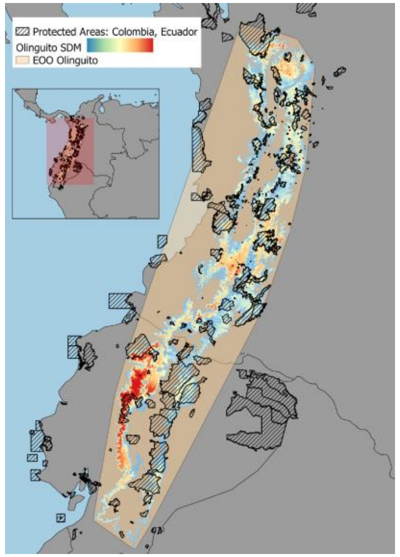
# Blair-Expanding Wallace, a tool for species distribution modeling

Mary Blair, Center for Biodiversity & Conservation, American Museum of Natural History

Co-authors: P.J. Galante, N. Horning, P. Ersts (AMNH), M.E. Aiello-Lammens, S. Chang (Pace U.), B.E. Gerstner (Michigan State), V. Grisales-Betancur (U. Eafít), J.M. Kass (OIST), C. Merow (UCONN), D. López-Lozano, E. Suarez-Valencia, E.A. Noguera-Urbano (I. A. V. Humboldt), J. Velásquez-Tibatá (Audubon), B. Johnson, G.E. Pinilla-Buitrago, A. Paz, R.P. Anderson (CCNY-CUNY)

1. *Wallace* is an R-based, user-friendly, modular application for reproducible **modeling of species distributions** (SDMs).
2. We expanded *Wallace* as a tool for assessment and reporting by Biodiversity Observation Networks (BONs) by developing **two new R packages** and adding them to *Wallace* as modules. The new packages leverage **Remote Sensing** products to post-process SDMs to estimate current ranges and calculate key biodiversity indicators and their change over time & space.
3. We also integrated *Wallace* with **the Colombia BON's existing BON in a Box tool *BioModelos*** to facilitate updating of species' range and indicator calculations.




GROUP ON EARTH OBSERVATIONS


BioModelos

MEJORES MODELOS CON EL APOYO DE EXPERTOS

biomodelos.humboldt.org.co

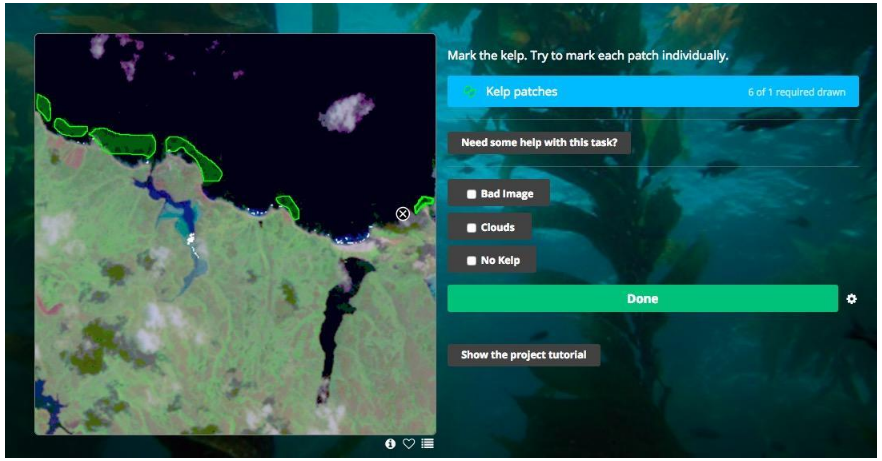
BON IN A BOX REGIÓN LATINOAMÉRICA

# Byrnes – Cultivating a (Floating) Forest of Citizen Science

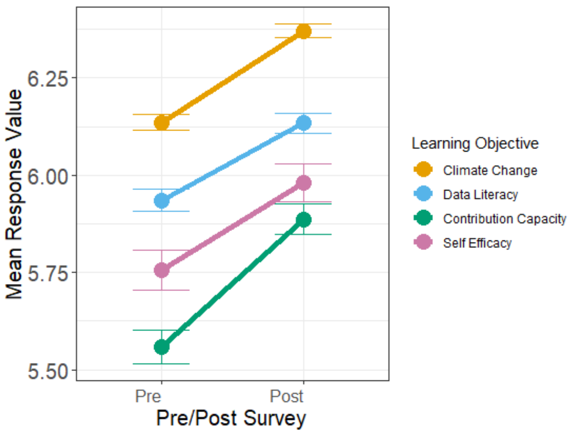

Jarrett Byrnes, University of Massachusetts Boston

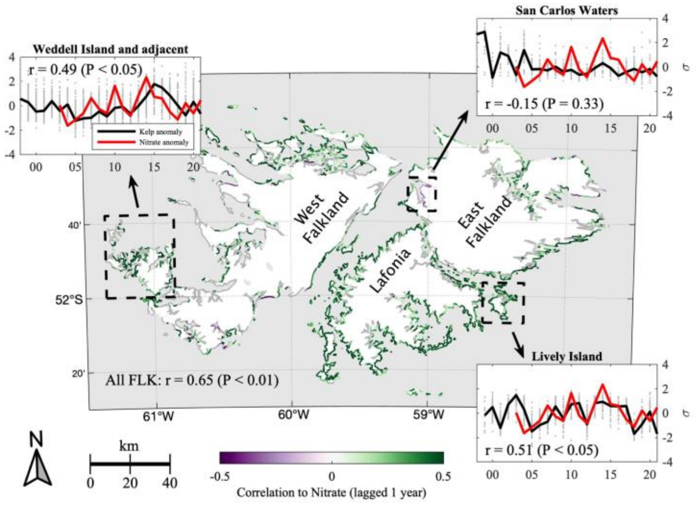
Kyle C. Cavanaugh, Laura Trouille, Alison Haupt, Henry Houskeeper Isaac Rosenthal, Chelsea Troy


- A citizen science begins as outreach to solve a data limitation problem – but it results in so much more.
- The Floating Forests kelp mapping project on Zooniverse has resulted in engagement with tens of thousands of people performing hundreds of thousands of Landsat classifications at http://floatingforests.org.
- As the project has grown, we've gone from documenting abundances over time with solid accuracy to projects evaluating range expansions, urbanizations, and, soon, efficacy of machine learning.
- Through it all, we've shown that engagement with people increases their understanding of science while adding new data.
- We hope that *you* will develop your own pipelines using the new platform we've built for other remote sensing scientists.




Participation in Floating Forests Curricula Improves Learning Goals

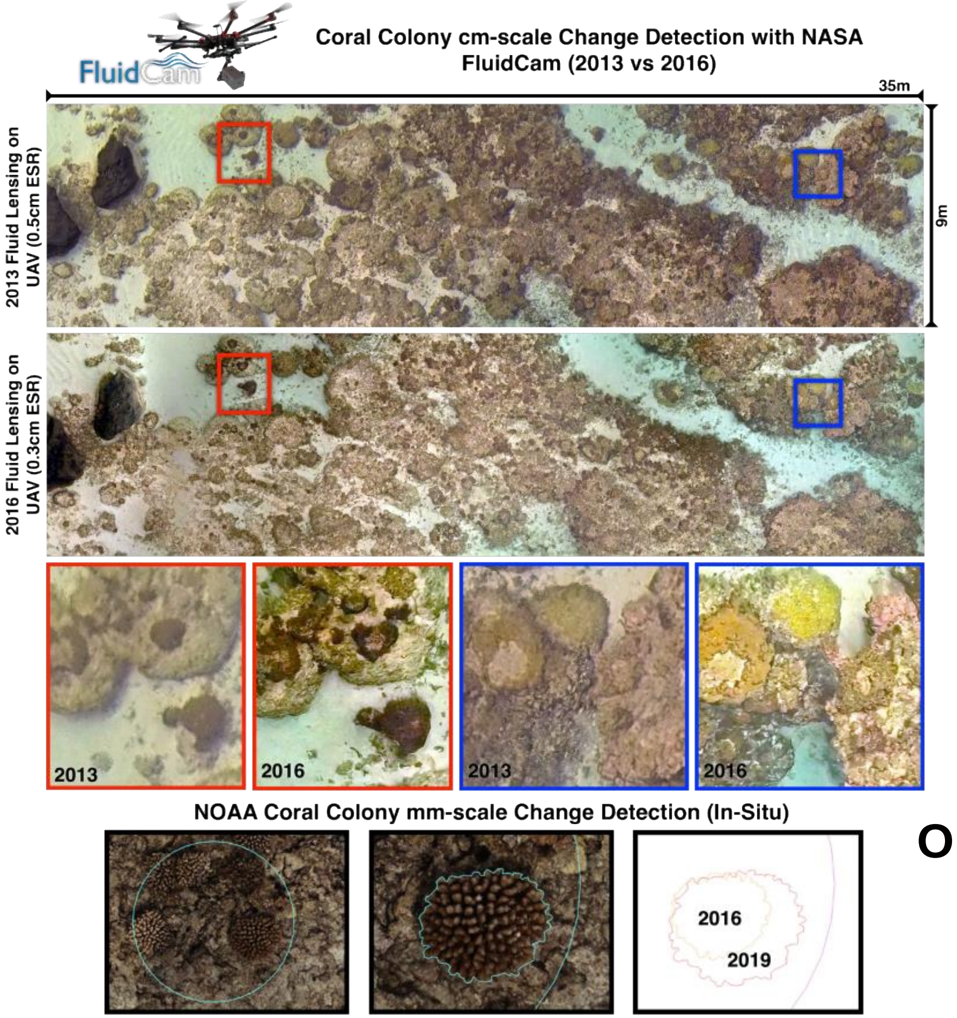


# Chirayath – MarineVERSE & PICOGRAM


Ved Chirayath, University of Miami, ved@miami.edu

Sam Purkis, Art Gleason, Alan Li, Jarrett van den Bergh, Courtney Couch, Tom Oliver


**MarineVERSE – The Marine Biodiversity and Scaling Project**

**Prediction of Individual Coral Organismal Growth, Recruitment, & Mortality (PICOGRAM)**

# Eegholm–Agent-Based Modeling of Giant Kelp

Nathalie Eegholm, University of California, Santa Barbara
Thomas Bell (WHOI), David Siegel (UCSB)

- Development of an agent-based demographic model of giant kelp at a kelp forest site in the Santa Barbara Channel
- Investigating spatiotemporal dynamics of giant kelp biomass and physiology
- Tracks plants and individual fronds through major processes of frond initiation and elongation; reproduction and plant recruitment; and plant and frond senescence and mortality
- Forced with environmental parameters: nutrients, light, temperature, waves

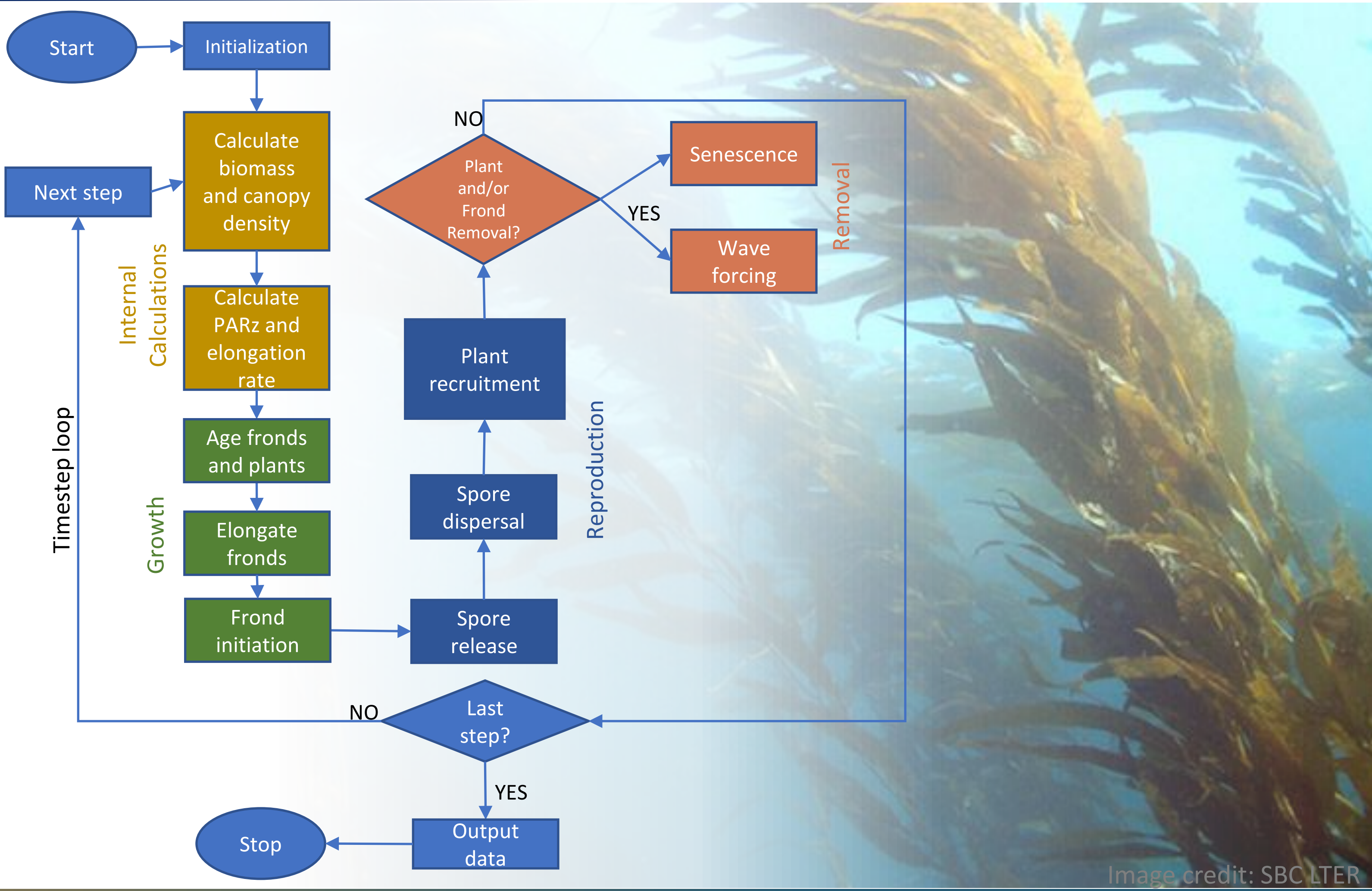



Image credit: SBC LTER

# Ferraz–Quantifying Seed Dispersal from Space

António Ferraz & Elsa Ordway; University of California, Los Angeles

**Motivation**: Integrating remote sensing and ICARUS animal tracking to understand seed disperser movements and their consequences across tropical rainforest gradients of structural and phenological diversity

## Team

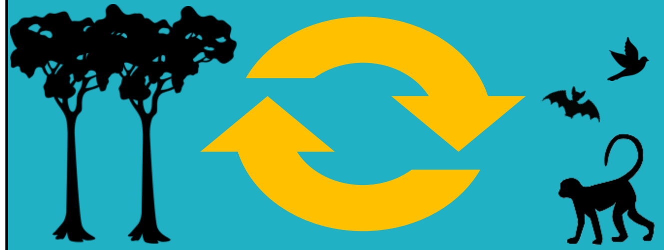
**PI:** Thomas Smith
**Co-PI**: Sassan Saatchi

**Co-I's**:
António Ferraz
Elsa Ordway
Margaret Crofoot

**Collaborators**:
Martin Wikelski
Matthew Luskin
Nicholas Russo
Vincent Deblauwe
Virginia Zaunbrecher
Matthew LeBreton
Nicolas Barbier

## Science Questions

How is the movement of seed-dispersers influenced by variation in forest structure, functional diversity, and phenology?



How does forest structure, function, and anthropogenic fragmentation influence animal movements and patterns of seed dispersal?

## Remote Sensing

Characterize tropical forest:
- Structure
- Functional diversity
- Phenology
- Degradation

GEDI
DESIS
ECOSTRESS
Landsat
SRMT
…
Drone LiDAR


DJA biosphere reserve (Southern Cameroon)
Credits: V. Zaunbrecher

## ICARUS

Track movement from space
(5 key seed dispersers:
- Birds
- Bats
- Primates
- Antel


Black-casqued hornbill
Dja reserve, September 2021

UCLA Institute of the Environment and Sustainability · Jet Propulsion Laboratory California Institute of Technology · Max Planck Gesellschaft · CBI Congo Basin Institute · The University of Queensland Australia · UC Davis University of California · IRD Institut de Recherche pour le Développement France

# Gholizadeh–Remote sensing of biodiversity in grasslands

Hamed Gholizadeh, Oklahoma State University

## Can spectral diversity be used to monitor plant diversity in grasslands?

Previous studies in grasslands were typically conducted in small experiments that

- did not resemble natural landscapes, and
- were highly controlled and manipulated.

But biodiversity in natural grasslands is the result of management practices, specially fire and grazing.

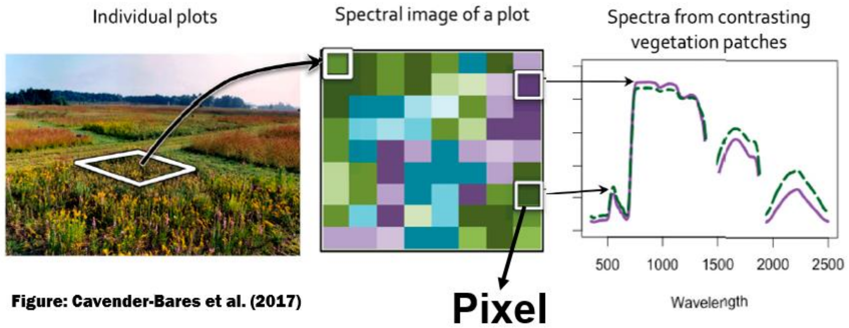


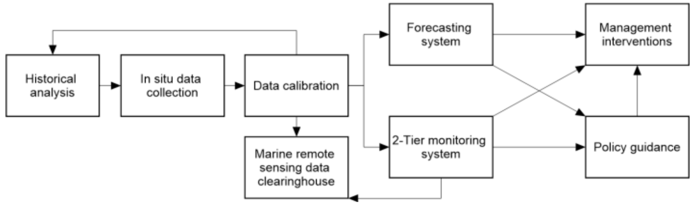

Figure: Cavender-Bares et al. (2017)

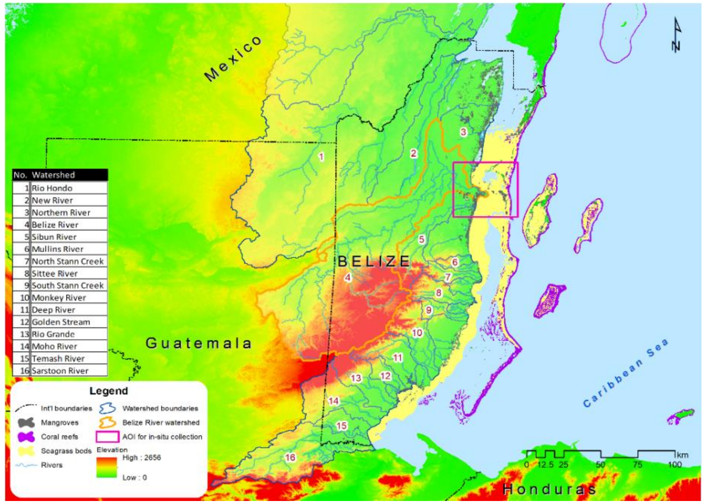
Are findings from previous remote sensing studies of biodiversity transferrable to natural grasslands?

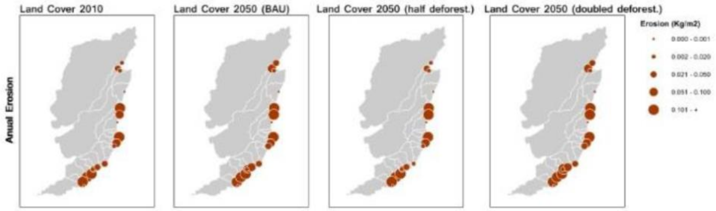
# Griffin–Nutrient Flows and the Belize Barrier Reef


Robert Griffin, University of Alabama in Huntsville (UAH)

Emil Cherrington (UAH), Deepak Mishra (UGA), Nicole Auil Gomez (WCS), Christine Lee (JPL)


- **Original Project timeline:** Nov. 2018-Nov. 2021 (3 years)
- **Funding:** NASA Applied Sciences Program SLSCVC Solicitation
- **Overall objective:** Support Belize w/ implementation of SDG 14 (“life below water”), and to lesser extent, SDG 15 (“life on land”)
- **Specific objectives:**
    - i. Utilize NASA, ESA data for assessing land impacts on marine envir.
    - ii. Develop national monitoring + forecasting capabilities for marine pollution
    - iii. Strengthen the CZMAI Coastal Data Center
    - iv. Transfer scientific + technical capacities to GOB entities
    - v. Develop policy recommendations re: meeting SDG 14 targets
- **Geographic focus:** Belize Barrier Reef Lagoon (marine segment), Belize River Watershed (terrestrial segment)
- **Focus areas:** monitoring of sediments, algal blooms across BBR lagoon
- **Local stakeholder organizations:** CZMAI, Dept. of the Environment, Fisheries Dept., National Met. Service, broader GOB
- **Linkages w/ international efforts:**
    - Group on Earth Observations (GEO): GEO Marine Biodiversity Observation Network (MBON), Americas Group on Earth Observations (AmeriGEO)
    - United Nations Sustainable Development Goals (SDGs)

# Hansen–SDG15: Maintaining Life on Land

A. Hansen, J. Veneros – Montana State Univ.; S. Goetz, P. Jantz, I. Gonzales, Northern Ariz. Univ.; J. Watson, O. Venter, Jose Aragon – Univ N. British Colombia; J. Ervin, A. Virnig, C. Supples – U.N. Development Programme

## Overview

In order to help countries sustain forest ecosystems, we have been working closely with leading scientific institutions and governmental ministries in Colombia, Ecuador, and Peru to use remote sensing and other spatial data to calculate comprehensive indicators, validate these indicators for national use, and make them available via a decision support system for policy development and reporting on SDG 15.

## Objectives

1. Assess the collaborating countries' needs for decision support regarding SDG15 under climate change
2. Project change to 2100 in forest structure and composition, vertebrate habitats, and water risk under scenarios of climate, socioeconomics, and policy
3. Use results to inform reporting and policymaking for SDG15
4. Develop an SDG decision support system

## Topics for Poster

SDG15 Indicators and Partners
Modeling Human Footprint
Analysis of riparian forest and hydrology
Projection of ecosystem types and vertebrate species.


## Scenarios

| Climate | Socioeconomic (Policy) | |
|---|---|---|
| | Business as usual | Conservation policies to meet SDG15 targets |
| RCP 4.5 | | |
| RCP 8.5 | | |

## Project Flow

**Goals**
SDG15 Targets

**Historic patterns**
SDG15 metrics 2000-2020

**Develop models**
Biodiversity response to climate and human footprint

**Potential future patterns**
Forecasts under scenarios 2020-2050

**Conservation planning**
Develop and implement plans to meet SDG15 targets based on what is learned from forecasts

**Monitor and evaluate**
SDG15 Indicators
SDG15 Metrics

**Report**
Status and change in SDG15 Indicators

## SDG15 indicators, metrics

| Target | Indicator | Metric |
|---|---|---|
| TARGET 15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements | 15.1.1 Forest area and natural forest area by ecosystem type | Forest area as proportion of ecosystem type area |
| | | Natural forest area as proportion of ecosystem type area |
| | 15.1.2: Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type | Average proportion of Terrestrial Key Biodiversity Areas (KBAs) covered by protected areas |
| | | Average proportion of ecosystem types covered by protected areas |
| | | Average proportion of high forest structural integrity areas covered by protected areas |
| TARGET 15.2: By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally | 15.2.1: Progress towards sustainable forest management by ecosystem type | Proportional distribution of forest integrity condition classes by ecosystem type |
| | | Forest fragmentation index by ecosystem type (all forest, high FSII forest) |
| | | Forest connectivity index by ecosystem type (all forest, high FSII forest) |
| TARGET 15.3: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world | 15.3.1: Proportion of land that is degraded by ecosystem type | Water quality and quantity |
| TARGET 15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development | 15.4.1: Coverage by protected areas of important sites for mountain biodiversity | As above for all ecosystem types |
| TARGET 15.5: Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species | 15.5.1: Protection of species habitats | Area of suitable habitats for selected vertebrate species |
| | | Average proportion of forest dependent species ranges covered by protected areas |

NORTHERN ARIZONA UNIVERSITY
UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA
CBCS Centre for Biodiversity & Conservation Science
UN DP
gef
MONTANA STATE UNIVERSITY

Photo: Amazon Watch

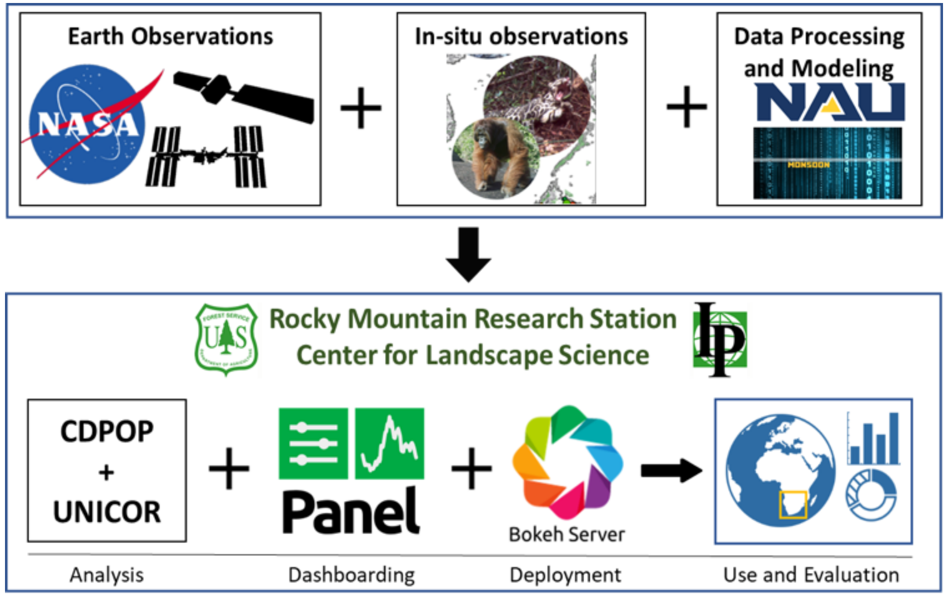
# Jantz–New Connectivity Tools for USFS International Programs

Patrick Jantz, School of Informatics, Computing, and Cyber Systems, Northern Arizona University
Scott Goetz (NAU), Żaneta Kaszta (NAU), Beth Hahn (USFS-IP), Sam Cushman (USFS), Kathy Zeller (USFS), Erin Landguth (U. MT), David Macdonald (U. Oxford), Nyambe Nyambe (KAZA), Saw Htun (WCS), Andrew Loveridge (Wildcat Trust)

1. We are partnering with USFS International Programs (IP) to develop web-based decision-support tools to assess protected area connectivity in Southeast Asia and sub-Saharan Africa.

2. Tools developed by this project will use remote sensing, camera traps, and state-of-the-art connectivity, population dynamics, and genetics models to quantify protected area contributions to connectivity for priority wildlife species.

3. A notable component of our approach is the use of Global Ecosystem Dynamics Investigation (GEDI) lidar with extensive WildCRU camera trap observations to improve estimates of connectivity for species dependent on structurally complex forest habitat.




4. USFS-IP provides technical expertise on protected area management via partnerships with host country agencies and NGOs. Our tools will inform partner decisions by evaluating specific scenarios which reflect actual land use, development, and conservation options available to them.

# Jongsomjit–Understanding Adélie Penguin Winter Ecology

Dennis Jongsomjit, Point Blue Conservation Science
Annie Schmidt, Amélie Lescroël, Simeon Lisovski, David Ainley, Grant Ballard

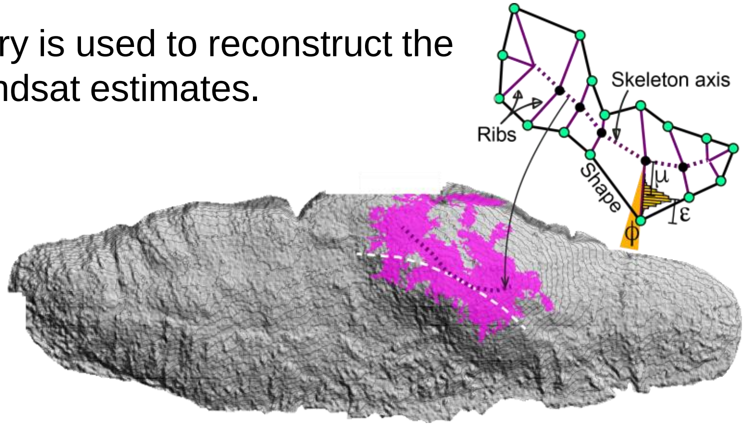
1. Adelie penguins are key indicators of ecosystem function in the Ross Sea but relatively little is known about their wintering ecology.
2. We combined penguin location and foraging data with AMSR-2 sea ice data to examine yearly changes in relation to the boundaries of the Ross Sea Region MPA (RSRMPA).
3. We identified winter foraging hot spots for the first time, showing partial overlap with the RSRMPA.
4. We identified molting areas and associated ice conditions for the first time - largely (but not entirely) within the boundaries of the RSRMPA and varying by colony.
5. We found that sea ice movement facilitates penguin travel with ice assistance accounting for up to 30 additional km travelled per day.
6. Our findings emphasize the importance of the RSRMPA, and raise concerns about the future ecosystem function of the Ross Sea, particularly as sea ice concentration, wind, and ocean currents are all projected to change in the coming decades due to climate change.

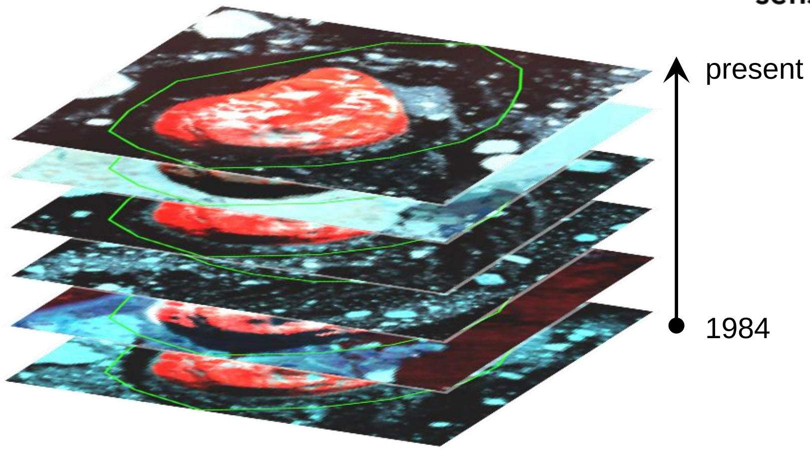
# Lynch–Image super-resolution for population tipping points

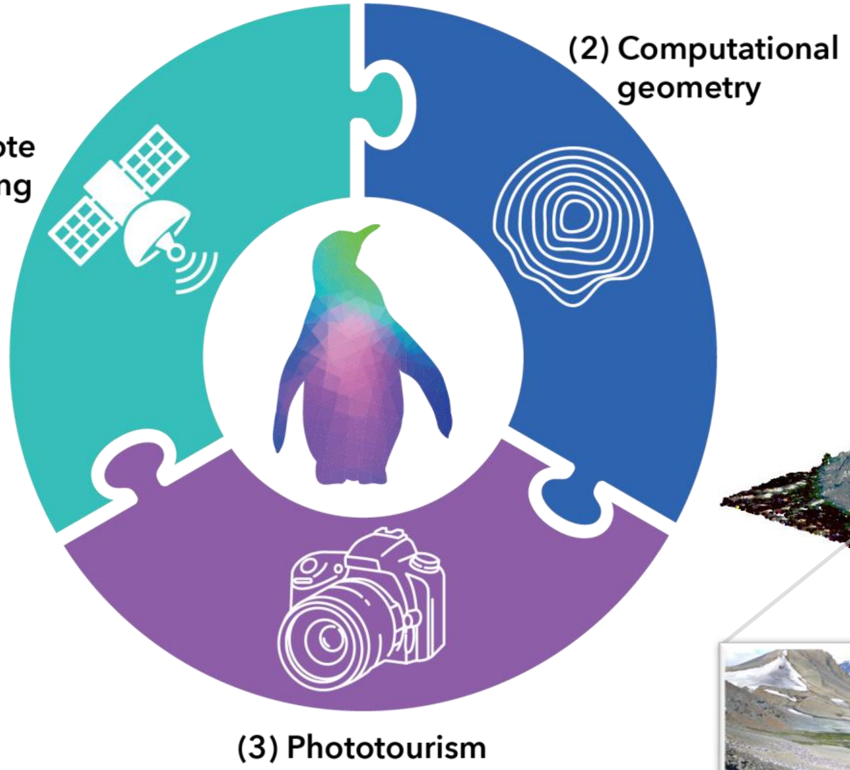
Heather J. Lynch, Christian Che-Castaldo, Dimitris Samaras, Matthew Schwaller, Stony Brook University
Ph.D. students: Carole Hall (Applied Math), Alex Graikos (Computer Science), Clare Flynn (Ecology)

**Step 1**: Landsat images over penguin colonies are georegistered and stacked for a super-resolution methodology based on ’detection modelling’ in wildlife ecology.

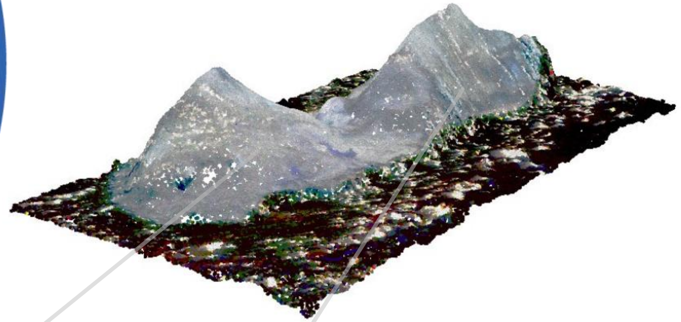
**Step 2**: Computational geometry is used to reconstruct the most likely shape given the Landsat estimates.




- processed 20,502 Landsat 5-7 images from 1984 to present



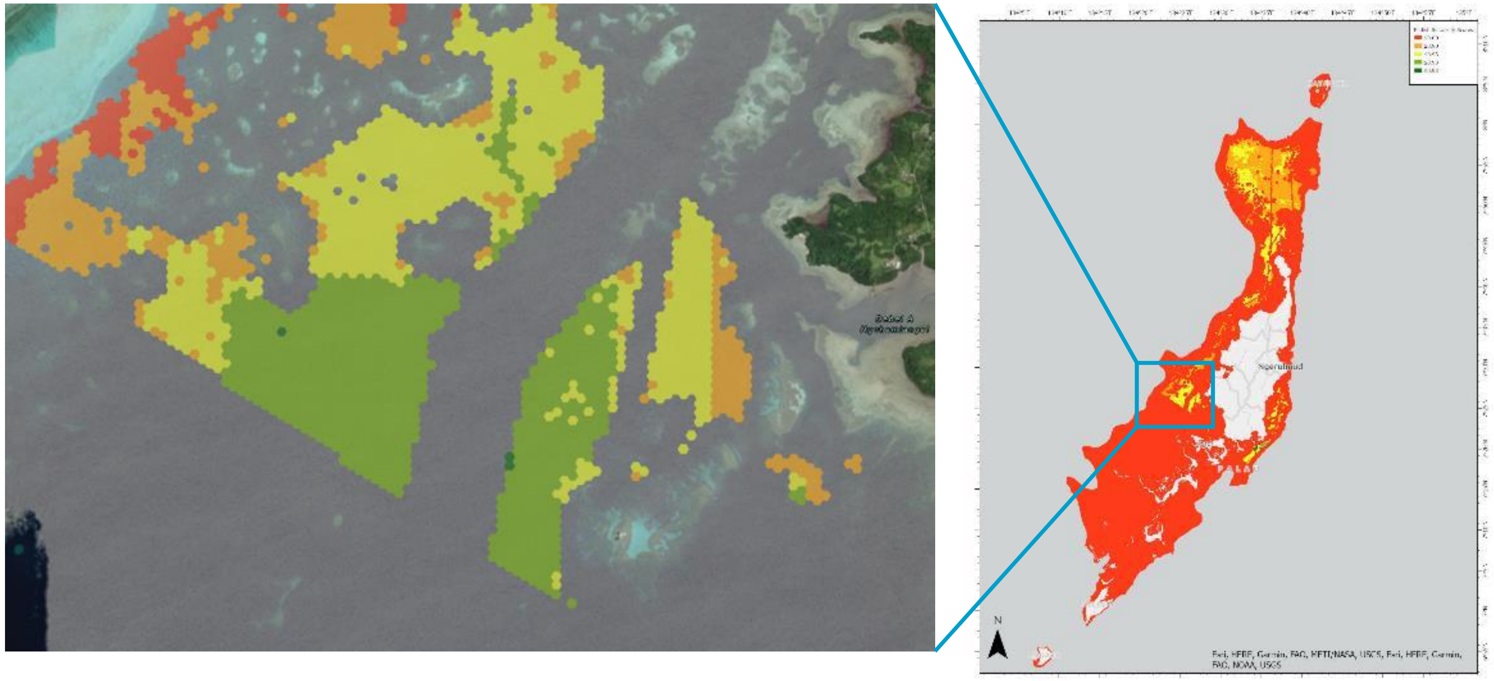
**Step 3**: Photographs of the Antarctic landscape taken by tourists can be aligned to digital elevation models and the colony boundaries extracted as a constraint on shape reconstruction.

# MacKay–Aquaculture Management and Siting in Palau

Jonathan MacKay, Contractor CSS, Inc. in support of The Nature Conservancy (TNC)
Yvonne Ueda[1], Michael Aulerio[1], Robert Jones[2]
[1]TNC Micronesia, [2]TNC Global Aquaculture

## Earth Observations for Climate-Ready Aquaculture Management and Siting to Improve Food Security and Ocean Health in Palau, a Small Island Developing State

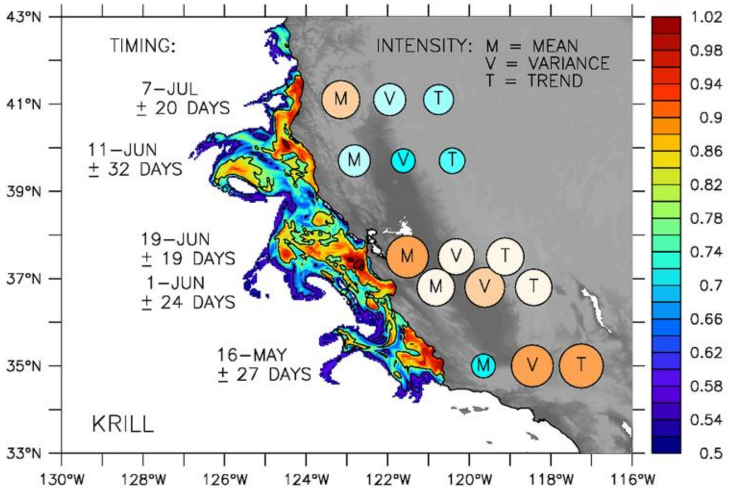
- Development and Results of Aquaculture Site Suitability Model
- Integrating Remotely Sensed Data
- Satellite Derived Bathymetry
- Training and Mentorship
- Stakeholder Engagement



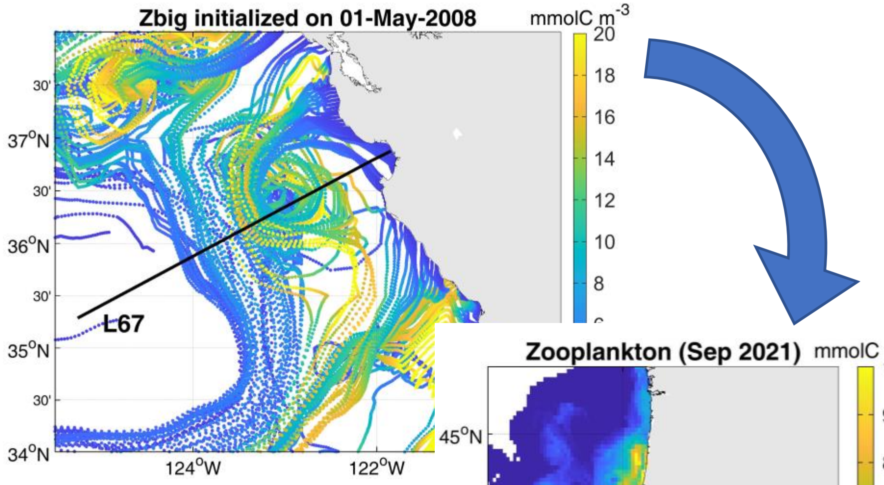
# Messié – Zooplankton hotspots in a moving ocean

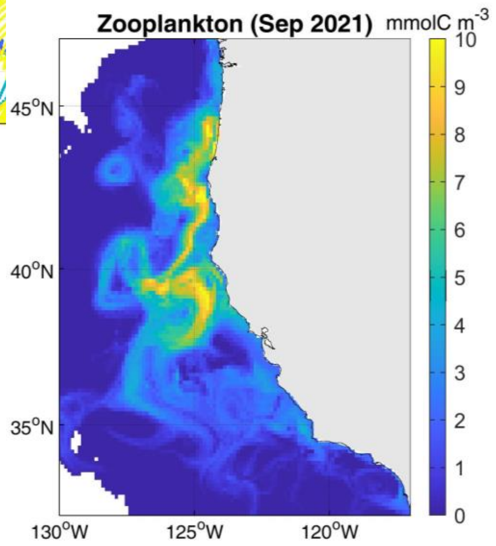
Monique Messié, Monterey Bay Aquarium Research Institute
J. Fiechter (UCSC), J. Santora (NOAA), F. Chavez (MBARI)

## Coupled physical-biogeochemical model

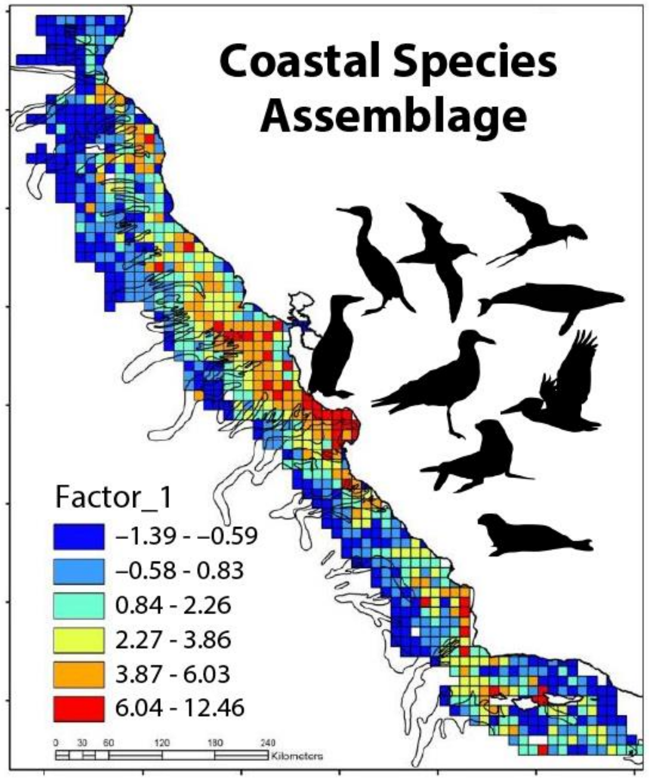



## Satellite-based growth-advection model




## Yearly krill & ecosystem surveys

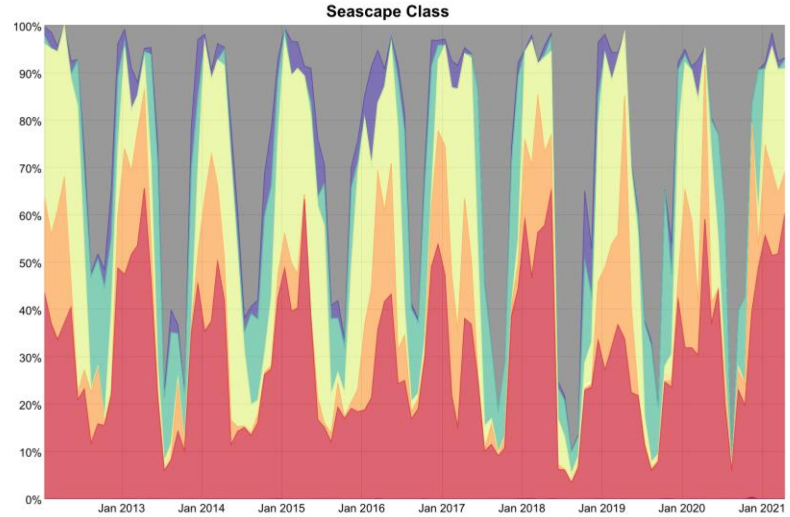



- Krill hotspots location, seasonal patterns, interannual variability, environmental drivers
- Links between krill and ecosystem hotspots
- Monthly satellite-derived zooplankton maps 1993-present available online

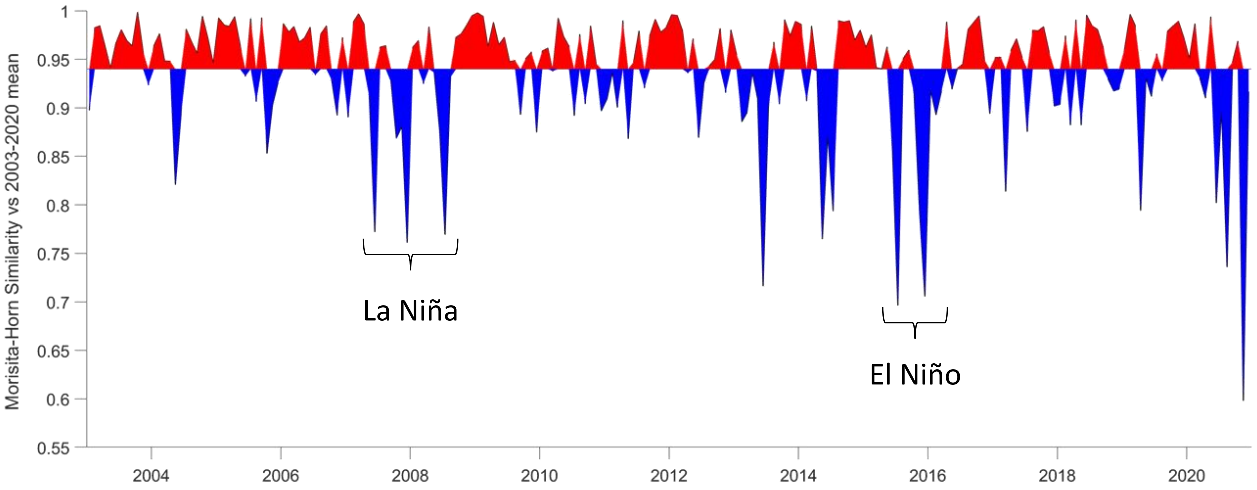
# Montes – Seascape make-up drive fish biodiversity of the Peruvian shelf

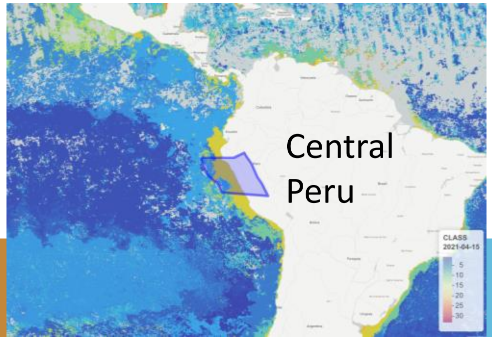
Enrique Montes, NOAA Atlantic Oceanographic and Meteorological Laboratory (NOAA AOML)
Maria Kavanaugh (OSU), Frank Muller-Karger (USF), Chris Kelble and Joaquín Trinanes (NOAA AOML), Luis Escudero-Herrera (IMARPE)

## Detecting biogeographic shifts using seascape identity and extent

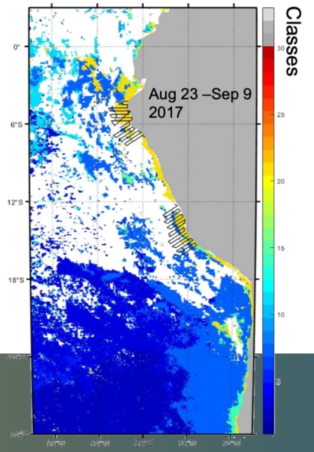


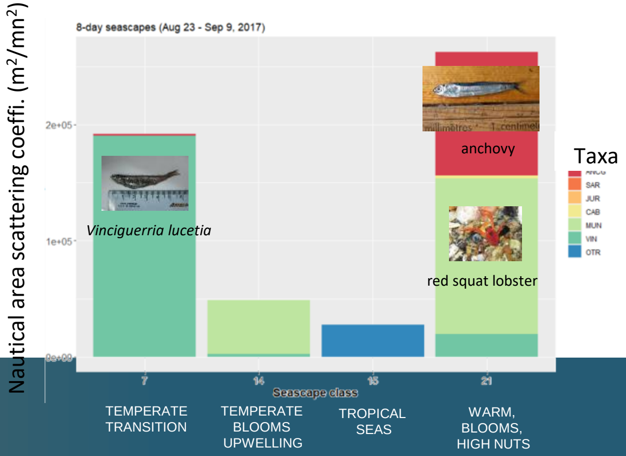

Class identity + extent
*Ecosystem Structure*
EBV




Instituto del Mar del Perú



# Myers–Variability of Water Transparency and its Drivers in the Hudson River

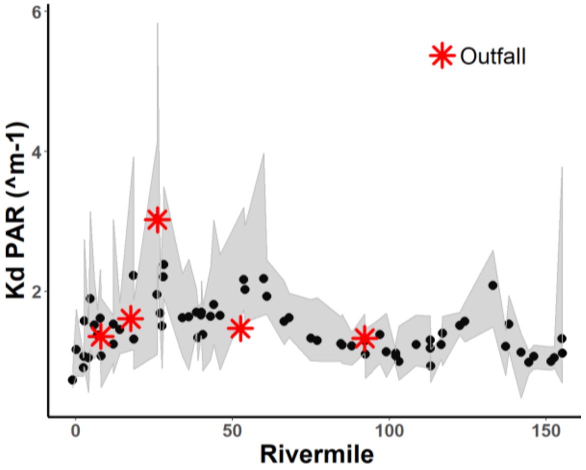

Elise Myers, Columbia University & Lamont Doherty Earth Observatory

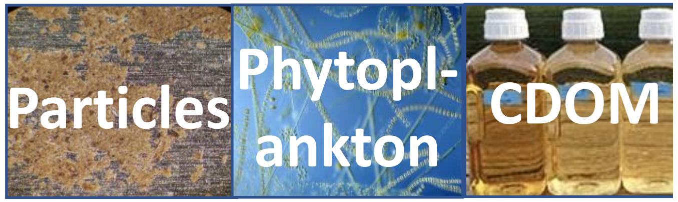
Andrew R Juhl, Ajit Subramaniam, Carol Knudson

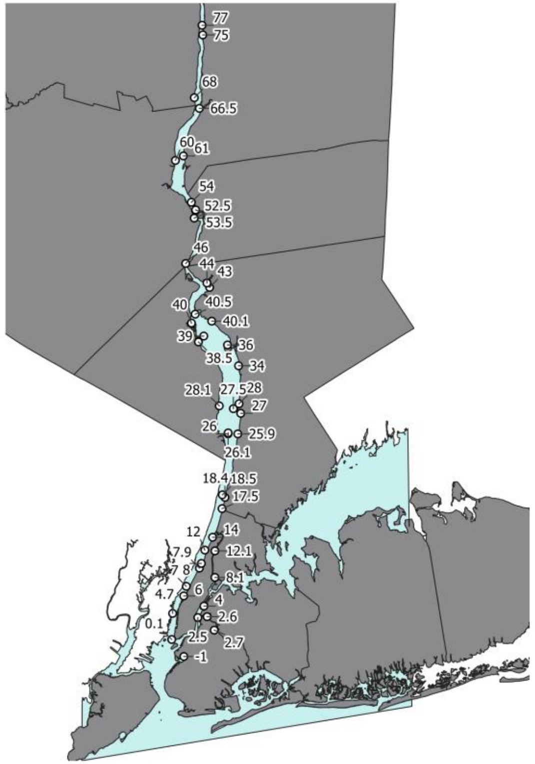

## In the Hudson River Estuary…

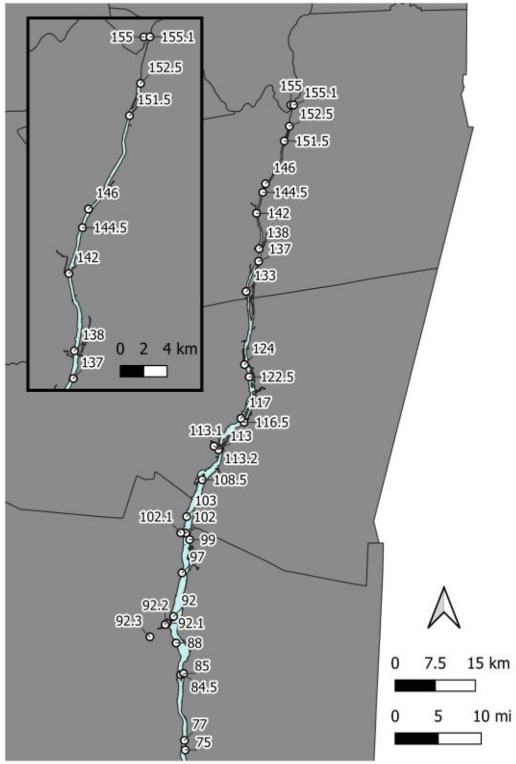
**Q1** How does water transparency vary spatially and temporally?

**Q2** What are the primary drivers of water transparency?



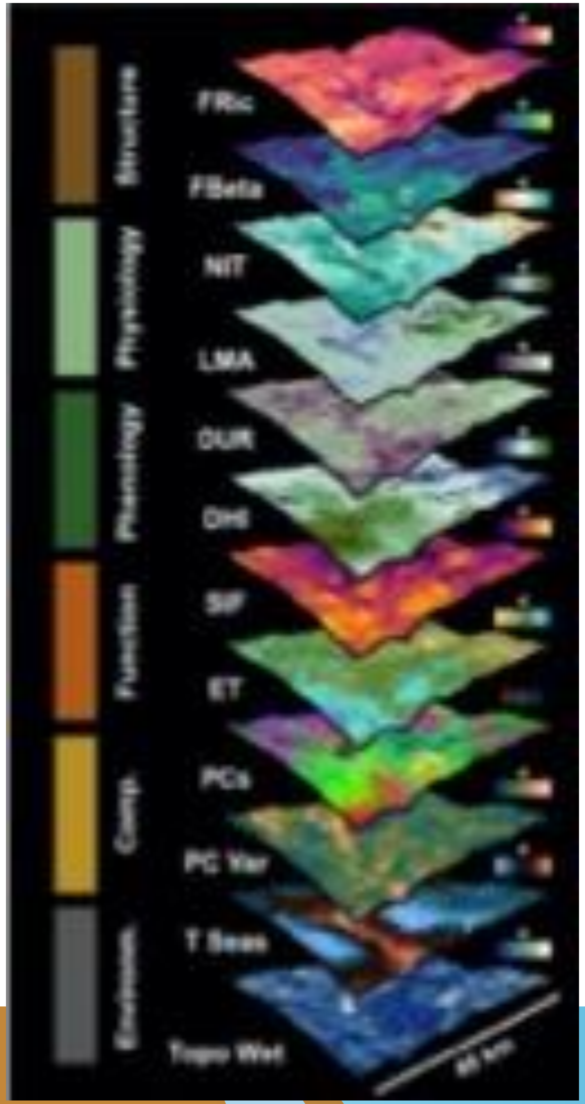



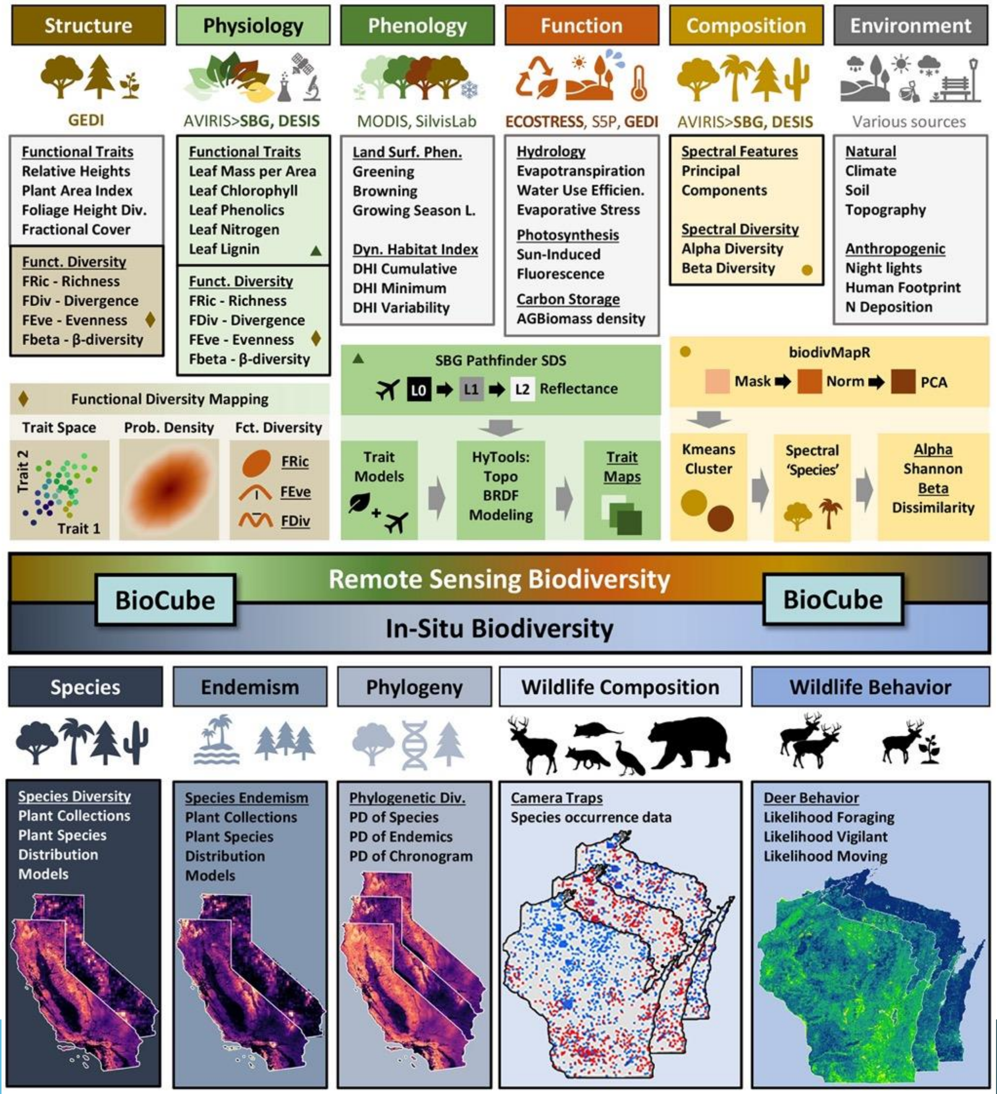



# Pavlick–BioCube


***Ryan Pavlick***[1], Fabian D Schneider[1], Philip A Townsend[2], John D.J. Clare[3], Ting Zheng[2], Natalie Queally[2], Adam Chlus[1], Zhiwei Ye[2], Morgan Dean[1,4] and Camila Cortez[1,2]

(1) Jet Propulsion Laboratory, California Institute of Technology (2)University of Wisconsin-Madison (3) University of California, Berkeley, (4) University of Michigan


We are developing an open-source data cube framework, ***BioCube***, that integrates six major dimensions of biodiversity that can be measured from space on a common spatiotemporal grid at 1 km resolution.

We plan to address four key science questions using BioCubes covering large parts of California and Wisconsin:

1) How are the dimensions of biodiversity related to each other, and what is the predictability of in-situ plant species richness, endemism and phylogenetic diversity from space-based remote sensing data?

2) What are the roles of functional, taxonomic, phylogenetic and spectral diversity in predicting the magnitude and stability of ecosystem function at large spatial scales?

3) How well do the BioCube remote sensing dimensions predict animal community composition and biodiversity using matrix dissimilarity and macroecological models?

4) How do BioCube remote sensing dimensions relate to aspects of deer behavior?

# Podest – A Tool to Map Forest Cover in Panama

Erika Podest, Jet Propulsion Laboratory, California Institute of Technology
Co-Investigators: Amita Mehta (UMBC JCET & NASA), George Chang (JPL/Caltech) Student: Reetam Majumder (UMBC)
Collaborators from the Ministry of the Environment of Panama: Roney Samaniego, Javier Martinez, Vaneska Bethancourt

## Project Objective:

The objective of this project is to develop a tool (SFMIS) for addressing SDG 15.2.1, which consists of tracking net forest area change in Panama. The tool calculates current and historical forest cover and determines trends in forest cover change through time.

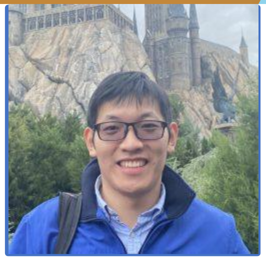
## Poster Overview:

-Intercomparison of Derived Landcover Maps: These include MODIS, PALSAR Forest/Nonforest, and Global Forest Watch.

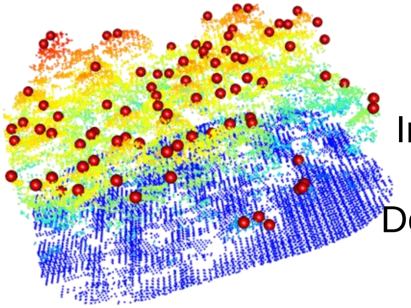
-Development of Landcover maps: Our methodology uses Random Forest with optical (Sentinel-2 and Landsat), SAR (Sentinel-1 and PALSAR), and ancillary data to generate landcover classifications.

-Structure and Capabilities of the SFMIS Tool: This includes a description of the inputs and outputs to the tool, its mapping and analysis capabilities.

# Qiu–Combined LiDAR and Hyperspectral Imagery for Forest Reproduction

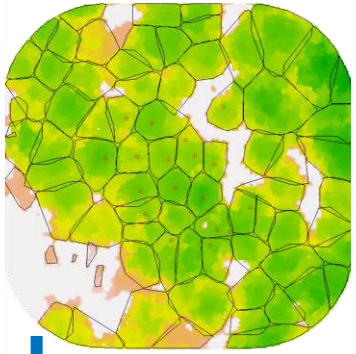



Tong Qiu, Nicholas School of the Environment, Duke University
James S. Clark, Philip A. Townsend, and Jennifer J. Swenson

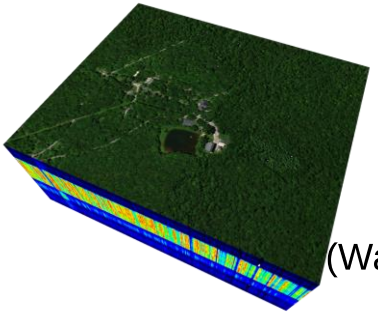



**LiDAR**

Individual Crown Delineation

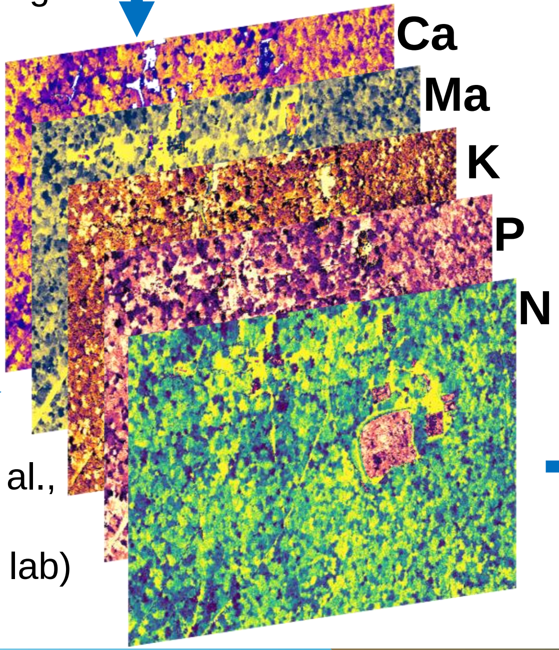


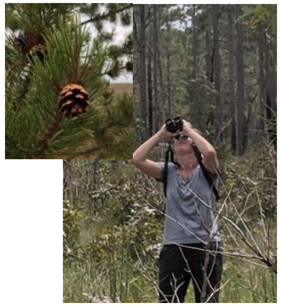
aggregation



**Hyperspectral data**

Traits Model (Wang et al., 2020; Townsend lab)

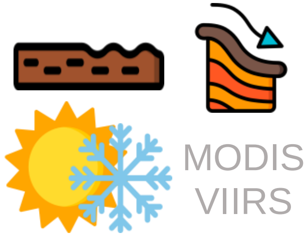


Crop Counts

Seed Traps

Data model



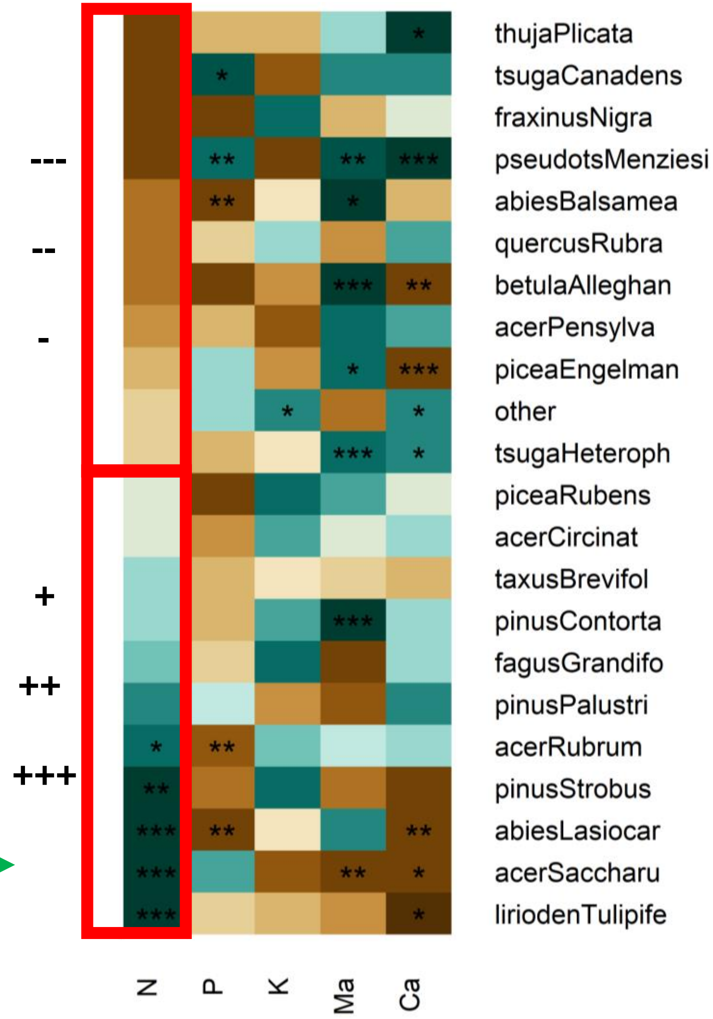

Environment

Individual Attribute

MASTIF model (Clark et al., 2019)

**Canopy Nutrients** + **Seed production**

**6000+ Crowns, 13 NEON sites, 34,000 tree-years**



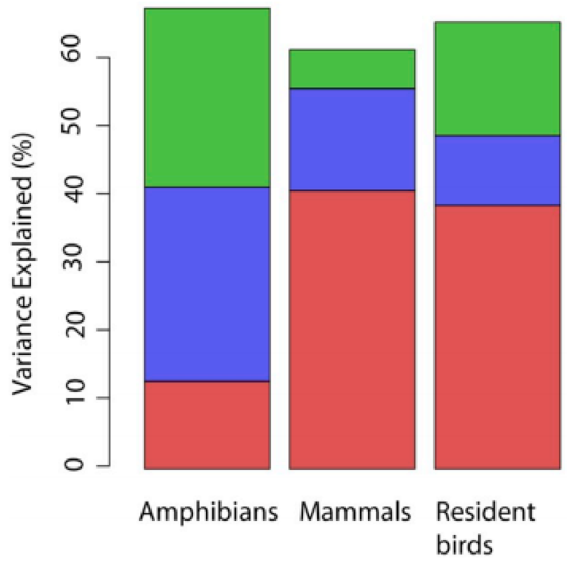
# Radeloff – The DHIs from Terra, Aqua, Suomi NPP and JPSS

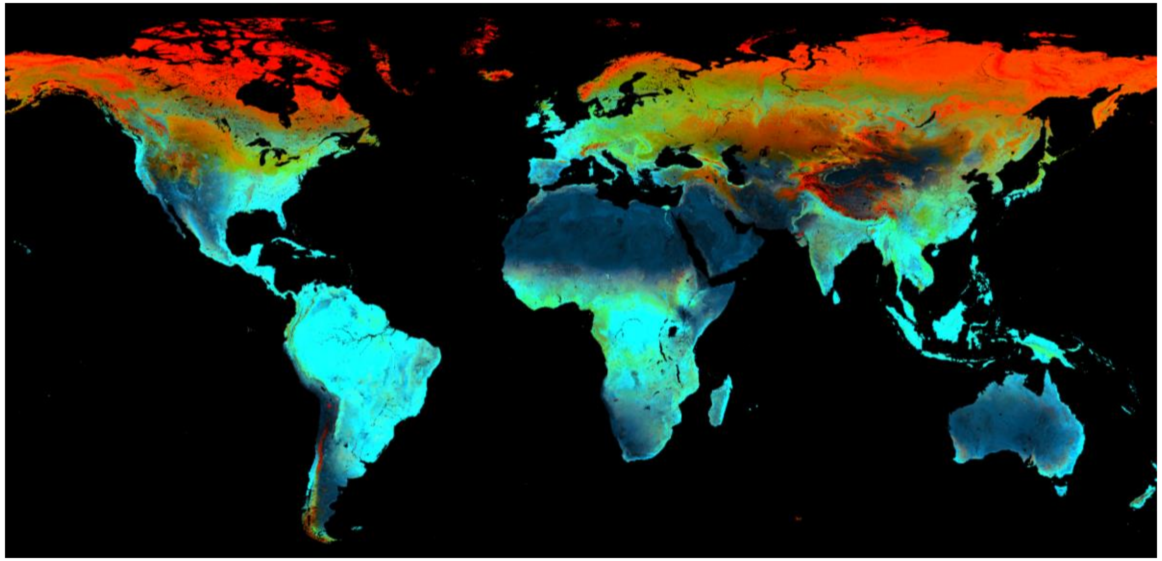
Volker C. Radeloff, University of Wisconsin-Madison
E. Silveira, A. M. Pidgeon, N. C. Coops, M. Hobi, A. R. Ives, D. Gudex-Cross, and E. Silveira

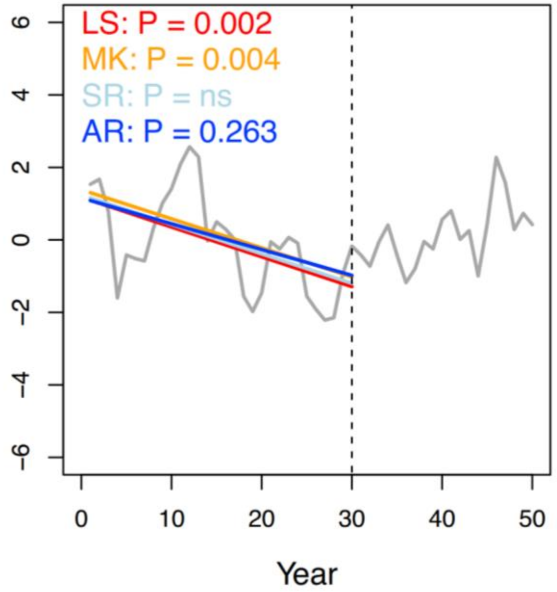
- The Dynamic Habitat Indices (DHIs) capture three aspects of annual productivity: cumulative (green, minimum (blue), and variation (red)
- Globally, the DHIs explain the majority of species richness in amphibians, mammals, and birds

- Here, our remote sensing goal is to create a continuous time-series of DHIs from Terra, Aqua, Suomi NPP and JPSS data
- Our scientific question is to identify where the DHIs have changed significantly – in a statistical sense

- Updating DHIs from C5 to C6/7, and adding Suomi NPP/JPSS VIIRS data to time series
- Developing QA flags and write an ATBD
- Reassessing biodiversity models, adding reptiles
- Analyzing trends in the DHIs with new statistical methods that account for temporal and spatial autocorrelation





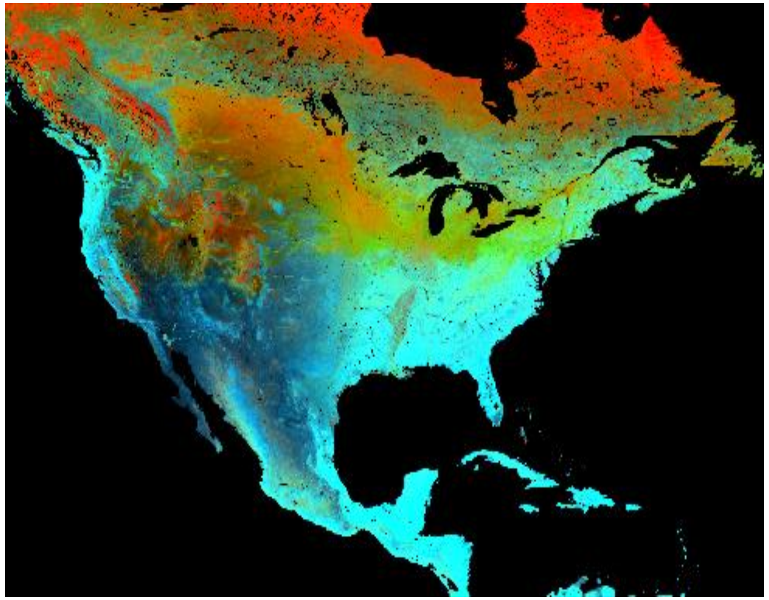
# Radeloff – Multi-scale DHIs and Bird Biodiversity

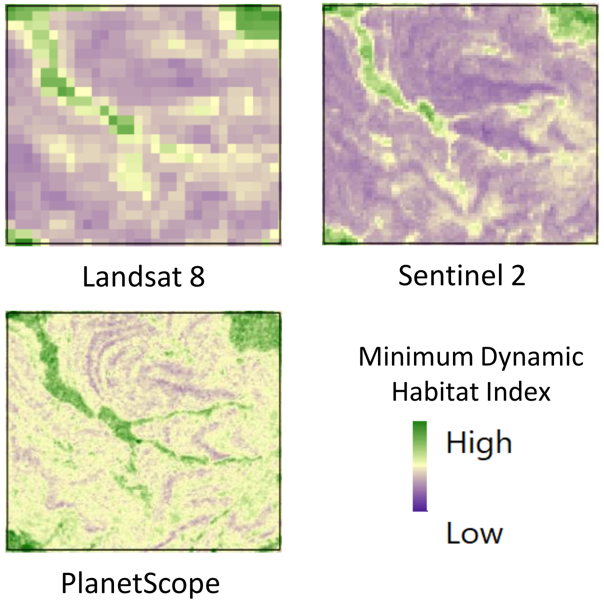
Volker C Radeloff, University of Wisconsin-Madison
E. Silveira, A. M. Pidgeon, B. Zuckerberg, L. Farwell, A. Bar-Massada, N. Coops, M. Hobi, and A. Ives

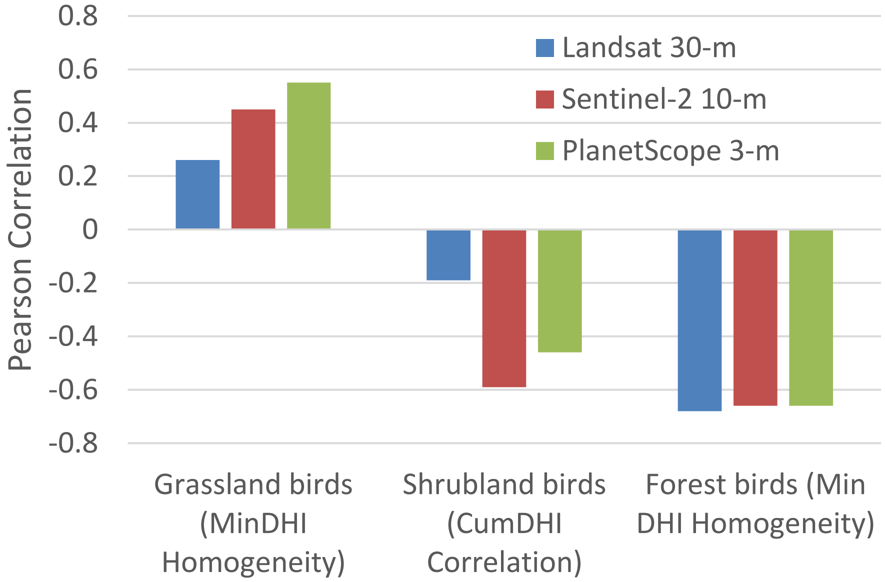
- The Dynamic Habitat Indices (DHIs) capture three aspects of annual productivity: cumulative (green, minimum (blue), and variation (red)
- Across the US, the DHIs explain bird species richness in various gilds well

- Here we ask how scale, both resolution and extent, affects DHIs-Biodiversity relationships
- Ultimately we will develop new multi-scale habitat indices (Curious?  See my poster!)

- Initial results are exciting
- Different satellite sensors capture DHIs at different resolution nicely
- For some grassland birds, texture of fine 3-m resolution DHIs is best, but not for shrubland or forest birds

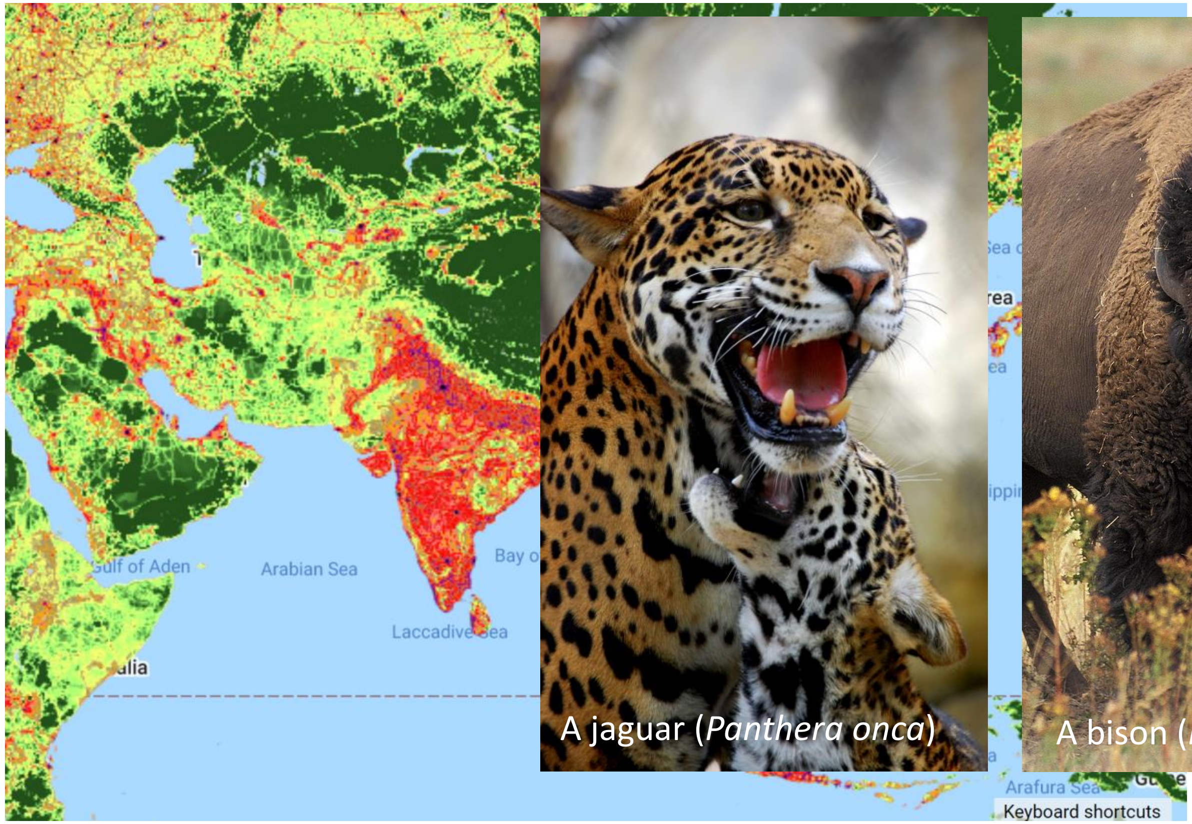




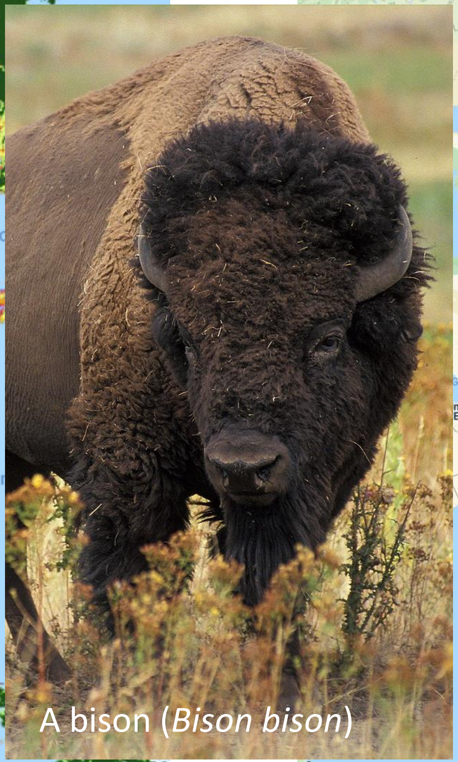



# Sanderson-ActGreen: Tracking the recovery of jaguars, lions, and bison

Eric W. Sanderson, Wildlife Conservation Society
Jon Paul Rodrigues, IUCN – Species Survival Commission
Volker Radeloff, University of Wisconsin - Madison




A jaguar (*Panthera onca*)



A bison (*Bison bison*)

Human footprint, 2020

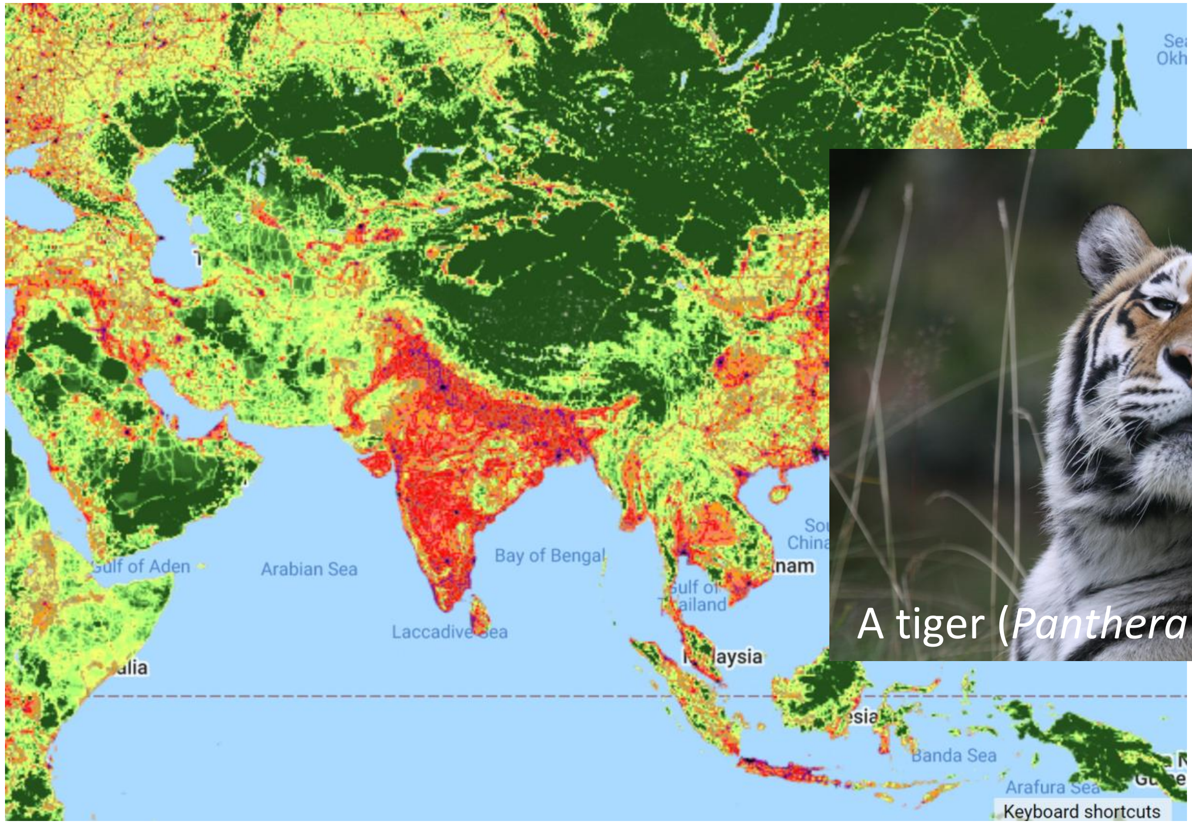

A lion (*Panthera leo*)

Tiger conservation landscapes, 2020

Also: how do such species habitat tools help report on Sustainable Development Goal (15) for tigers?

# Sanderson-What SDG 15 needs: an application for tigers

Eric W. Sanderson, Wildlife Conservation Society
Dale G. Miquelle, Wildlife Conservation Society
Matt Hansen, University of Maryland – College Park




Human footprint, 2020

A tiger (*Panthera tigris*)

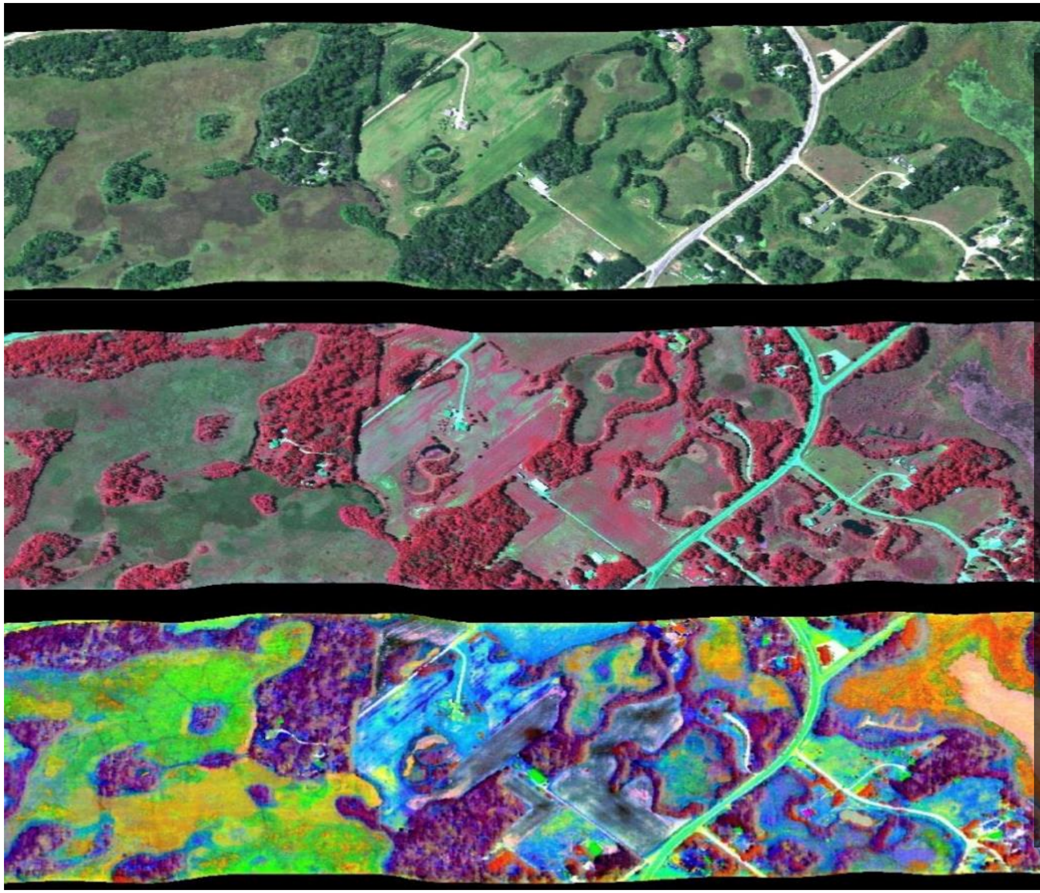

Tiger conservation landscapes, 2020

Also: what does this mean for jaguars (*Panthera onca*), lions (*Panthera leo*), and North American bison (*Bison bison*)?

# Townsend–ImgSPEC: Cloud-Based On-demand Spectroscopy Processing

Philip Townsend, University of Wisconsin-Madison

Natasha Stavros (University of Colorado), Hook Hua, Sujen Shah, Winston Olson-Duvall (JPL)



- There is an increasing flood of data such as imaging spectroscopy (*aka* hyperspectral) data available to the scientific community
- Because of its high dimensionality, hyperspectral imagery has great potential for both biodiversity and ecosystem research
- There is an ever-growing community of who want to incorporate the products derived from these data sets into their research
- These users may not have the resources to generate products from hyperspectral imagery on their own (for example, functional diversity)
- ImgSPEC is a prototype of an open-source cloud-based processing system that enables image and algorithm discovery, as well as on-demand product generation

# Zaiats–Applying Landscape Demography to Improve Ecological Restoration

Andrii Zaiats, Boise State University
Dr. Trevor Caughlin, Boise State University

Wildfires in the Western U.S. threaten local ecosystems and their permanent transformation.

Ecological forecasting will be key in planning and achieving long-term restoration targets.

UAS

ECOSTRESS

LANDSAT